Casting in the Home Workshop

THE MODEL ENGINEER

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In this issue

A magnificent impression of heavy locomotive work caught by the camera of Mr. M. W. Earley. The train is an Anglo-Scottish express, hauled by Engine No. 5538, "Giggleswick," climbing the famous Shap bank, L.M.S.R.

THE MODEL ENGINEER

Vol. 92 No. 2283 — Percival Marshall & Co., Limited, Cordwallis Works, Maidenhead — February 8th, 1945

Smoke Rings

American Railroad Hobbyists

OUR U.S. contemporary, *The Model Railroader*, recently conducted an exhaustive enquiry among its readers as to the circumstances in which they followed the hobby. As the result of the 5,000 replies received it reports that the average age of the model railway enthusiast is 34, his annual income is in the region of £700, and that of this he spends from £18 to £20 a year on his hobby. The most popular gauge in use is "HO," numbering 2,602, closely followed by "O" gauges, of which there are 1,944. The continuity of interest in the hobby is shown by the fact that over 4,000 readers have been enthusiasts for more than three years, and that of these over 2,000 have a five years' record of active participation. Some 4,500 have had high school or college education, and no less than 77 per cent. of them are married. The total yearly expenditure on the hobby indicated in the replies received is over 60,000 dollars. The reader figures quoted apply to about one-third of *The Model Railroader* subscribers, so when multiplied by three they become very impressive. The averages and percentages would, of course, apply equally to the larger field. This has been a war-time enquiry and it is confidently anticipated that in post-war days there will not only be a considerable influx of new hobbyists, but that many existing lay-outs will be re-modelled and brought up-to-date.

To Old Romfordians

THE new Chingford Club, which has made a very successful start, has appointed Mr. A. B. Carrington to act as press secretary. Mr. Carrington performed this duty for the Old Romford Club, of which he has very pleasant memories. He would particularly like to hear again from some of his old Romford friends. His address is 13, Nightingale Close, Hatch End, Chingford, E.4.

The Hastings Exhibition

PREPARATIONS for the forthcoming exhibition at Hastings in April next are moving ahead. The Borough and Water Engineer, Mr. Sidney Little, M.Inst.C.E., has kindly consented to open the show, the profits of which are to be devoted to the Royal East Sussex Hospital. The exhibits will comprise all classes of model making and kindred handicraft work, and five certificates of merit will be awarded in each class. The opening ceremony will take place at 3 o'clock on Wednesday, April 11th, and the show will continue for the three following days, from 11 a.m. to 9 p.m. It will be held in the Lecture Hall of the Robertson Street Congregational Church, and entry forms may be obtained from the Hon. Secretary, Mr. Walter T. Dunn, 72, Elphinstone Road, Hastings.

Coulsdon Calling

WITH a New Year resolution to help in forming a local society Mr. S. Franklin invites "lone hands" in his district to make contact. His address is "Oakleigh," Caterham Drive, Old Coulsdon, Surrey.

Locomotives in Lancashire

A NOTE from Mr. J. L. Waterhouse, of the Wigan Society, promises some interesting track days for locomotive lovers in Lancashire. He says that "these will be of more than usual interest to our members and friends." The Wigan Society, after seven years of activity, is still active and robust in spite of the small annual subscription of 7s. 6d. on which it manages its affairs. A February lantern lecture will be given on "Locomotives Past and Present."

Lathe Permits

THE hope I expressed in my note last week about the modification of regulations covering the purchase of lathes and machine tools was only a day removed from its achievement. The new Order, which came into operation on February 1st, disposes of the obligation to obtain an official permit in order to buy a lathe, so that my readers are now free to convert their enquiries into definite orders. This will not only stimulate lathe production, but will make many dreams of improved equipment for the home workshop come true. Better lathes will make for better model making.

Percival Marshall

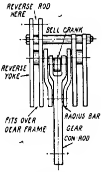
Baker Valve-Gear for 3½-in. Gauge Locomotives

By "L.B.S.C."

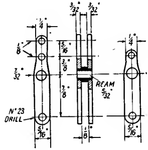
ONE of your humble servant's New Year resolutions was to try to clear up outstanding promises as opportunity arose and circumstances permitted; so here are the long-deferred dimensions and sketches of the Baker valve-gear adapted to 3½-in. gauge engines. Some of the good folk who follow these notes, have built locomotives of this size, and "scaled up" the dimensions I gave some years ago of the Baker gear for 2½-in. gauge; but there has been a slip-up somewhere, in more than one case, as I have received direct complaints, and also been informed by others who have either seen the engines working or have actually driven them, that they will not notch up properly. Incorrect distribution is plainly indicated either by jerky motion, uneven beats, or both. The pinhole centres indicated in the accompanying illustrations, if followed out accurately, should obviate any syncopation or other discrepancy, and provide a steam distribution as near perfect as possible, provided, of course, that the workmanship is reasonably accurate and that there is no bad slackness in the pin joints. The dimensions were obtained from the drawings of the full-sized Baker valve-gear issued by the makers; but the same so on, but can get busy and make a perfectly successful gear with a few bits of steel, your own workshop tools, and a small modicum of what the classics call "common savvy."

The Best Invented

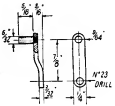
For beginners' especial benefit, I might here repeat that the Baker valve-gear is, in my humble opinion, the best outside radial valve-gear ever invented. It suits any type of engine without any alteration whatever; it is made on the "unit construction" principle, the whole issue being assembled in a frame either of girder or bracket type as desired, and hung up in the most convenient place for coupling up to the return crank and valve spindle; there are no slotted links and die-blocks to bother about, and there is no die-slip when working, because there are no dies to slip; so the valve gets the full benefit of all the movement going. When the gear eventually wears, all you do is to put one size bigger drill through the holes, and fit new pins to match. On a full-sized locomotive, they simply undo a few bolts, lift off the complete gear, replace it by a reconditioned one, and the engine goes out without losing even one turn of



End view of assembly.



Reverse yoke.



Radius bar.

method of construction could not be adopted, as the big engine's gear is made up from drop forgings and stampings, some of which are rather intricate, the complete one-piece reverse yoke being a good example. Regular readers know by this time, how fond I am of making the job so easy that any raw tyro should be able to follow without trouble; therefore you don't have to bother about complicated forgings and duty. Any running-shed foreman can tell you what a sincere blessing *that* is! Well, let's get to business.

Gear Frame

I have shown both types of frame. Both are made from ⅛-in. steel plate, to the given dimensions. The exact shape of the frame doesn't matter very much, so long as you get the pinhole centres O.K. For an extra

posh job, the bottom holes may be bronze-bushed, but this is only a refinement, because the only movement of the pins working in them is a fraction of a turn when the engine is reversed or notched up. The pivot of the oscillating cylinder of a child's toy steam engine makes more movements in a couple of minutes than the reverse yoke is likely to make in the whole lifetime of the locomotive to which it is fitted.

Motionless !

There is no movement whatever in the upper holes ; they merely carry the ends of the pin on which the bell-crank works. NOTE : The hole on the inner frame is drilled $\frac{1}{8}$ in., and on the outer, it is 5/32 in. The reason is that, the bracket frame being brazed up, it would be impossible to get the pin in place if both ends were shouldered down to fit $\frac{1}{8}$-in. holes in each side ; and although one side of the girder frame is detachable, it could not be got over the shoulder of the pin without springing the reverse yoke and probably bending it. Therefore, the easy way out is to shoulder the pin at one end only, push it through the 5/32-in. hole, and secure it with a nut on the outside of the frame with the $\frac{1}{8}$-in. hole in it.

The distance-pieces for the girder frame are two $\frac{3}{4}$-in. lengths of $\frac{1}{2}$-in. by $\frac{1}{4}$-in. steel or brass. They should be squared off truly to dead length in the four-jaw, and secured either by bolts passing clean through the lot, or by countersunk, round, or hexagon-headed screws. The easiest way to hold the bracket frame for brazing in the end-plate, is to put two temporary bolts through each pair of holes, with a bit of tube $\frac{3}{4}$ in. long on each bolt between the frames, to act as distance-pieces. Then file the end-plate to a tight jam fit between the frame ends, and it will " stay put " whilst you operate with blowlamp or blowpipe.

Types of Frame

In case beginners get into a quandary as to which type of frame would best suit their locomotive, the girder frame is used where a link girder would be used on an engine fitted with Walschaerts gear ; for example, the Pacifics of the L.M.S., or the Southern Railway's " King Arthurs." The bracket type is used where the guide-bar yoke is placed right at the end of the bars, as on the Southern " Moguls " of classes " N " and " U " ; and the bracket is bolted to the extended top of the guide-bar yoke, with the open end towards the back of the engine. I know of several " Dyak " builders who have fitted Baker gear to them and obtained excellent results, the bracket frame being used and erected in place of the bracket which carried the original Walschaerts link.

Reverse Yoke

Now we tackle the components, which are easy enough to make and fit. All the reverse yoke consists of, is four bits of 3/32-in. steel strip, $\frac{5}{16}$ in. wide, drilled and filed as shown in the sketch. Two long ones and two short ones are needed ; the reverse rod eye fits between the two long ones. Here is a permissible variation : the reverse-rod connections can be made either side or in the middle, to suit the particular type of engine. If in the middle, put the bearing bush between one long piece and one short piece, and erect with the two longer ones on the inside of the gear frame. The reverse-rod can then be attached to the middle of the pin, which is passed through the two holes, a distance-washer each side keeping it central. On my engine " Tugboat Annie," all four pieces of the reverse yoke are short, and the reverse-rod acts on the distance-bolt over the bell crank. This was necessary to get the complete gear below the running-board. The bearing bushes are merely $\frac{5}{16}$-in. lengths of $\frac{5}{16}$-in. bronze rod, shouldered down for 3/32 in. length each end, to a tight squeeze fit in the 7/32-in. holes in the reverse yoke members. Drill No. 24 before parting off, then re-chuck truly, and run a 5/32-in. parallel reamer through. There shouldn't be any slop in valve-gear joints, because it only needs a little slackness in each one to get as much as $\frac{1}{16}$ in. or more lost motion at the valve spindle.

Radius Bars

The radius bars are made from two pieces of 3/32-in. by $\frac{1}{4}$-in. strip steel, set over 3/32 in. as shown. The lower end is drilled No. 23, and the upper, 9/64 in. and countersunk slightly. The 5/32-in. pin, which should be silver-steel, is shouldered down to a drive-fit in the 9/64-in. hole, forced in, riveted over and filed flush. Beginners note : The distance between centre of pin and centre of bottom hole is $\frac{7}{8}$ in. *after bending*.

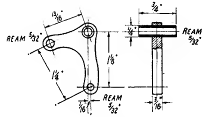
Gear Connecting-rod

My own pet way of making a " sickle," as it is sometimes known from its shape, is to cut it out of the flat. If you *bend* it to shape, the chances are that the dimensions will be all out. An easy way is to mark out the dimensions on a piece of $\frac{3}{4}$-in. by $\frac{3}{16}$-in. steel bar, and saw and file to outline ; then braze a 3/32-in. thickening piece at each side of the straight end, cut to length, and slot out the fork either on a milling machine if available, or else by the lathe method, same as I described for the forked joints in

the valve gear of "Petrolea." Anybody who has the use of a milling machine can, if they feel like it, chaw the whole issue out of a piece of $\frac{3}{8}$-in. by $\frac{3}{4}$-in. steel bar, which naturally makes the best job.

Bell-crank

This is a straightforward bit of work, easily sawn and filed from a piece of $1\frac{1}{4}$-in.

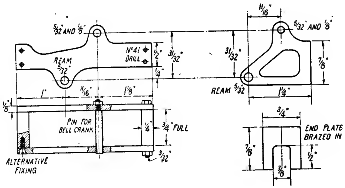


Bell crank.

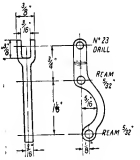
by $\frac{3}{16}$-in. flat mild-steel. Don't forget the tip about using a drop of cutting oil on the hacksaw! In case beginners get into difficulties in marking out correctly, first set out the top and bottom holes in the vertical member, noting that the bottom one is $\frac{1}{16}$ in. off centre, and make centre-pops at each point. Set your divider points $1\frac{1}{4}$ in. apart, and strike an arc from the bottom pop mark in the direction of the north-west corner. Reset them to $\frac{13}{16}$ in. apart, and then steer south-west from the upper mark, cutting the first arc. Make your third pop-mark at the level crossing, and Bob's your uncle! That's easy enough, sure—*ly*, as they say down Sussex way. Drill the upper hole 15/64 in., and ream it $\frac{1}{4}$ in., either on a drilling machine, or in the lathe, as described in the "beginners' guide"; for the hole has to go through dead square. Now part off a $\frac{3}{8}$-in. length of $\frac{1}{4}$-in. bronze rod; rechuck it truly in the three-jaw, centre, drill right through No. 23, and ream 5/32 in. Squeeze it into the $\frac{1}{4}$-in. hole in the bell-crank, and drill a weeny oil hole in the top, at each side. This sleeve must be a perfect fit on its spindle; for if the bell-crank emulates one of friend Hambleton's paddle steamers, and rocks sideways as well as fore-and-aft, the valve events aren't going to be any too good—eh? what's that? Oh yes, they do; I'll say they do! Yo-heave-ho, with the accent on the "heave." I once went to Yarmouth on the *Clacton Belle*, but I came home on one of "Petrolea's" sisters; 'nuff sed!

How to Assemble the Gear

The best way of putting the whole bag of tricks together, is to start from the middle and work outwards. The pins are made from 5/32-in. round silver-steel, and the first job is to see if it fits the reamed holes properly. Silver-steel varies slightly in diameter; it isn't *supposed* to, but there are a dickens of a lot of "not-supposed-to" things which actually happen in this benighted world, especially at the present time! Anyway, taper the end of a piece of 5/32-in. round silver-steel very slightly, and try it in the middle hole of the gear connecting-rod. It should fit exactly without shake; if tight, enlarge the hole a weeny mite, as the rod must work freely on the pin. This goes for every hole in the gear in which a pin is a working fit; so I needn't repeat that instruction. Now take the gear connecting-rod, put a radius-bar each side of it, so that the bottom holes line up with the middle hole in the "sickle" (see cross section) and squeeze the bit of silver-steel through the lot. It should be a drive-fit in the No. 23 holes. Cut off nearly flush at each side of the radius bars, trim up the ends with a file, and very slightly burr them over. The two radius-bar pivots should line



Girder and bracket frames.



Gear connecting-rod.

up like the two halves of a crank-axle, the bars being exactly parallel.

The reverse yokes are then fitted to the radius bars by sliding the bushes over the pivots, and they are kept in position by a long bolt with three distance-pieces on it. Chuck a piece of $\frac{3}{16}$-in. round brass or steel rod; centre, drill down an inch or so with No. 30 drill, part off one piece a full $\frac{5}{16}$ in. long, and two $\frac{1}{8}$-in. washers. The latter are placed between the inner and outer parts of the yokes, opposite the $\frac{1}{8}$-in. holes, and the $\frac{5}{16}$-in. sleeve goes right across between the two yokes. The bolt is made from a piece of $\frac{1}{8}$-in. rod screwed at each end; it passes through the whole issue, yokes, washers, and sleeve, and is nutted at both ends.

Lining-up

Push the forked end of the gear connecting-rod clear of the radius bars; put the end of the horizontal arm of the bell-crank between the jaws, and pin it with a bit of 5/32-in. silver-steel, same as the joint immediately below. The whole complete gear is then placed over the frames, one section of each reverse yoke being outside the frame, and the other inside; the working parts, of course, go down between. Line up the holes at the bottom of the reverse yokes, with the corresponding holes in the frames, and squeeze in $\frac{5}{16}$-in. lengths of 5/32-in. round silver-steel. Line up the bell-crank bush with the upper hole; push the pin through from the 5/32-in. side, so that the shouldered-down and screwed end of the pin projects through the $\frac{1}{8}$-in. hole on the other side; put a nut on, and the gear is complete. Beginners note: If the reverse yoke is pushed right forward as far as it will go, and the hanging end of the gear connecting-rod waggled back and forth, the vertical arm of the bell-crank will move in the same direction, about a third as much. Pull the reverse yoke gradually back, still keeping up the same movement of the gear connecting-rod; the movement of the bell-crank will get less and less, until it merely "trembles" when the yoke is in mid-position. It will then reverse its direction as the yoke passes centre, finally resuming its one-third movement when the yoke is right back, but now going the opposite way to the gear connecting-rod; and this will naturally reverse the engine. The Baker valve-gear is very fascinating to watch in operation; old Abner Baker certainly had his noddle screwed on the right way when he schemed out this contrivance! It is only British conservatism, in my humble opinion, that has prevented its wide application to full-size locomotives in this country; the unit construction alone is a great feature, as no engine need ever be "shopped" for valve-gear repairs. Anyway, builders of little locomotives showed their discrimination by eagerly adopting the gear, as soon as I first described it; there are hundreds of little Baker-fitted locomotives all running successfully.

Hints on Erecting

The girder frame can be attached to the main frame by a bracket at each end, whilst a bracket frame is simply bolted to an extension of the guide-bar yoke, as previously mentioned. The exact position doesn't matter; but the gear works best when the bottom of the bell-crank is about level, vertically and horizontally, with the top of the combination lever, to which it is connected like a Walschaerts radius-rod.

The throw of the return crank should be sufficient to swing the bottom of the gear connecting-rod three times the valve travel in full gear. To get the correct position of the return crank and the length of the eccentric-rod, set the main crank on front dead centre; then set the gear connecting-rod in such a position that the valve spindle does not move when the reverse yoke is moved back and forth, and fix it there temporarily. Then set the return crank "by eye" approximately at 90 deg. to the main crank (leading it for slide-valves, and following it for piston-valves) and take the distance, with a pair of dividers, from the centre of return crank-pin to the middle of the hole in the end of the "sickle." Go around to back dead centre, and see if the measurement between points named is the same; if not, shift the return crank half the difference and try again. When they tally on front and back centres, the return crank is set correctly, and the distance between divider points is the exact length of the eccentric-rod.

To operate the gear from the cab, a weigh-shaft, or reverse shaft, is fitted across the frames at any convenient point behind the gear, and the two ends of this are furnished with vertical arms which are connected to the tops of the reverse yokes by short rods of equal length, so that both reverse yokes are operated simultaneously and kept "in step." An ordinary wheel and screw, or "pole" lever, is installed in the cab, and connected by the usual long reach-rod, either to an additional reverse arm on the end of the weigh-shaft, or one of the above-mentioned vertical arms could be extended to take the extra connection. Well, that will be all for this week about $3\frac{1}{2}$-in. gauge Baker gear; but if anybody hits up against any special problem in fitting it to any particular type of engine, sing out, and I'll be glad, circumstances permitting, to do my best to solve it.

Two Improved Workshop Aids

By A. G. JORDAN

VERY often the small lathe is called upon to cope with a job somewhat beyond its capacity, and the employment of extra power, either by treadle or motor, is apt to impose too great a strain on the lightly-built headstock and spindle; therefore, it is better to apply the available power in a more stress-free manner by the use of gearing.

The first adaptation to be described is a geared face-plate. This is a common feature of large gap and break lathes, but its employment on a small lathe is somewhat unusual. The advantages to be gained by using such a face-plate, however, repay the time spent on its construction; the largest diameter of turning or facing work within the capacity of the lathe may be carried out with less chatter or strain on the headstock spindle and its threaded nose. The driving torque acts on the face-plate at a greater radius than is possible in the ordinary spindle drive.

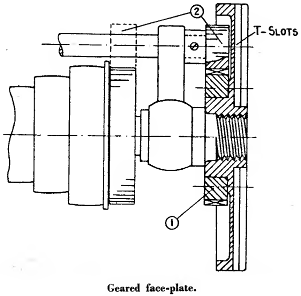
The first drawing shows the gear (1) which is of the same diameter and pitch as the spindle gear. This is bored out in the form of a ring, and pinned and screwed round a boss turned on the back of the face-plate. The back-gear of the lathe is of the sideways sliding type, and the pinion (2) is removed from its usual position and secured by key or grub-screw on the outer end of the back-gear shaft so that it meshes with the gear on the face-plate. Eccentric-meshing back-gears will require a longer shaft in place of the standard shaft.

The feed-shaft or lead-screw is driven by gearing from the spindle in the usual way. A word of warning is needed here. Should a heavy cut be taken, or any undue resistance be offered by the feed, the face-plate may be unscrewed from the spindle nose; care should be taken, therefore, to screw the plate firmly home.

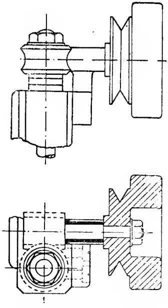
To remove a tight plate or chuck from the spindle with the minimum of strain or damage, a piece of hardwood of centre height should be stood on the rear bed-way, the upper end engaging a slot or jaw. The ordinary back-gear being in mesh, the belt is then pulled round in a reverse direction, and the chuck eased off without shock.

The second device is a worm-drive milling-head. The majority of attachments driven by belt from an overhead gear are inclined to be erratic in action, difficult to drive slowly by open belt, and noisy in operation when spur gears are employed to reduce initial high speed. A quieter and more even motion is obtained by using a worm and worm-wheel, as shown in the second drawing. A unique

(*Continued on page* 131)



Geared face-plate.



Geared milling-head.

Die Casting at Home

By L. G. CALLIS

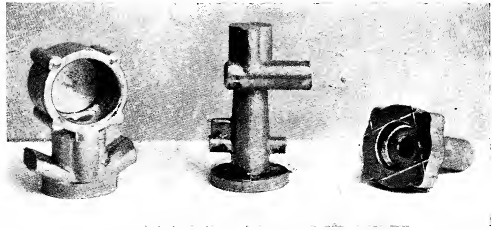
An account of a successful attempt to produce aluminium castings in the home workshop

OWING to the difficulty of obtaining aluminium castings, more or less off the shelf, I decided to experiment with their production at home. About this time, a friend of mine had acquired a very small centre lathe, and he asked me if I could possibly design him a small two-stroke, deflectorless petrol motor, capable of being machined on the lathe he had obtained. After tea that same evening, I made a few drawings of a small petrol motor, $\frac{1}{2}$-in. bore × $\frac{9}{16}$-in. stroke, incorporating a rotary inlet-valve. On giving the drawings to my friend, his next request was for some castings, and so I agreed to have a try at die-making.

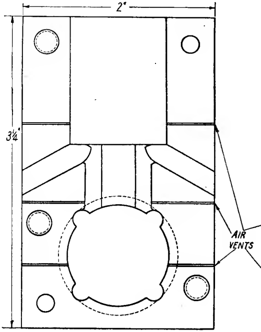
The first die that I decided to make was for casting the crankcase and lower cylinder jacket, and I started this by machining one side of each of two pieces of $\frac{3}{8}$-in. × 2-in. × $3\frac{1}{4}$-in. flat mild-steel, a cleaning cut being all that was necessary. I then marked out, drilled, tapped, and reamed these two pieces for the four bolts and two dowels; after this, I bolted the two pieces together, and then marked out the position of the bolt bosses of the crankcase, and the position of the holes for forming the transfer covers, which holes I then drilled. I then set up the two plates, still bolted together, in the four-jaw chuck, and bored out the $1\frac{1}{16}$-in. diameter hole for the crankcase, also machining the $1\frac{1}{4}$-in. diameter recess, which locates the lower core, at the same setting. (Note: Very few measurements appear on the drawings, which are to scale, for the sake of simplicity.) After this, I reset the job in the chuck, so that I could bore out the space required for the cylinder jacket. With these operations complete, I then drilled three holes in each side, at an angle of 30°, for the formation of the exhaust stubs; this operation required rather deep centre-drilling before attempting to use the ordinary twist-drills.

After this, I parted the two plates, and then with a file cut away the remaining surplus metal to complete the exhaust stubs. All sharp corners were eased off with a file and scraper, particular attention being given to the join of the crankcase and cylinder, also the join of the exhausts and cylinder.

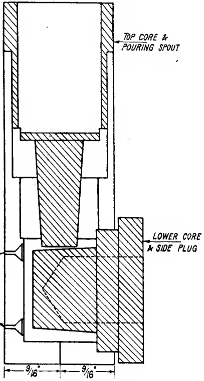
Venting of the die was then decided on, and I carried this out by drilling a 1/32-in. diameter hole in the centre of each crankcase boss, and by grooving the joint face of one-half of the die, 1/64 in. × 1/64 in.; this venting, by the way, I arrived at by degrees, and not all at once. After satisfying myself with this piece of work, I turned up the two cores shown in the drawings, the top core



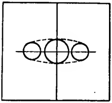
Three castings produced with the dies. The black patches are traces of soot from the die.



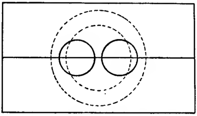
View of face of one half of die.



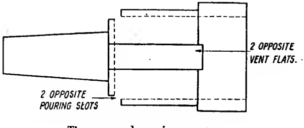
Crankcase and cylinder die.



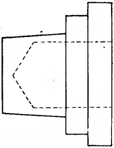
Section showing drilling for exhaust lugs, after which holes are joined by filing to dotted line.



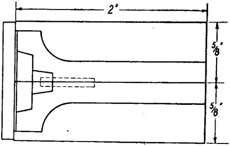
Top end of die, showing drilling for transfer ports before boring.



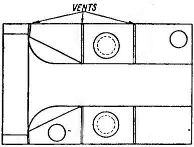
The core and pouring spout.



Lower core and side plug.



Die with base-plug *in situ.*



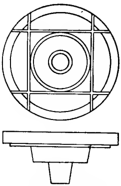
Face view of one die half.

being vented as shown, and pouring slots cut in. Everything was now ready for a trial, and the two halves of the die were lightly coated with soot from a smoky paraffin lamp, the two cores being treated in the same way. I then bolted the two halves together and fitted in the cores; the two lower bolts hold in the lower core by reason of their heads overlapping the flange of this. To cover in the holes at the sides, made by the exhaust stubs, a small steel plate was placed, flat on each side, and loosely held by a wire bound completely round the whole outfit. I then placed the die over a lighted gas ring to warm up, while I proceeded to melt some lead for a proof casting. The lead having melted, I placed the die on a small patch of asbestos; then I took hold of the ladle of molten lead and poured it into the die, stopping when the metal was showing level with the top of the pouring spout. After waiting a few minutes I gingerly removed the side plates and lower core, and then parted the die and removed the casting complete with the top core, after which I severed the runners with a hack-saw, and then removed the top core; and there it was—a perfect casting, but in lead.

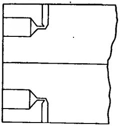
Everything was then set up again for the attempt in aluminium, the whole process being repeated; but, on opening the die, it was with great disappointment that I observed parts of the die had not filled at all. So I reasoned that more venting should effect a cure; and it did, as the next and successive casts have proved. Other failures in between have been put down to disturbing the die too soon after casting, and not having the aluminium or the die hot enough. Experience is the best teacher in these matters!

The next casting to be required was the crankcase end cover and main bearing housing, and the simple die shown in the drawings was made for this, the bolt boss holes again being drilled before boring, and the webs milled half in each die face after boring. Venting of the die caused no trouble this time, and I made several successful casts. Extraction of the casting is made by slackening the two bolts, and tapping the casting out lengthwise with a piece of rod.

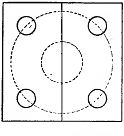
Well, having given my friend enough work, including other parts of the motor, for about a year (his spare time is very limited), I decided to make a die for casting the mixing-chamber of Mr. Westbury's famous "Atom R" carburettor, the pilot jet section being left out. As before, I used two pieces of mild-steel of the sizes shown; these



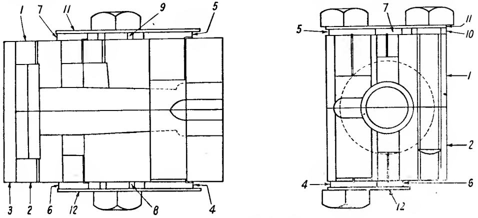
Base-plug and core.



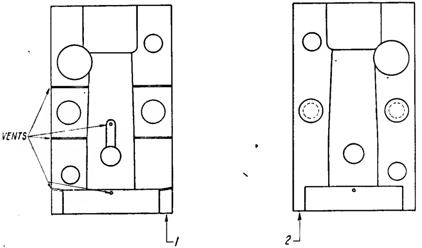
Section of vents to bosses.



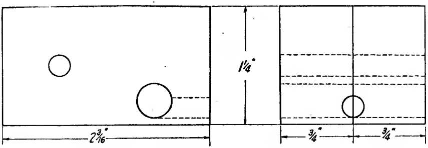
View showing drilling of bosses before boring.



Two composite views of carburettor die.

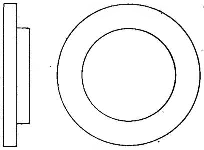


Open die blocks.

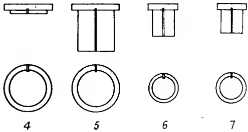


View showing drilling of die, before boring.

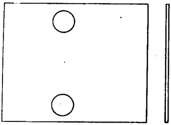
pieces were faced, marked out, drilled, etc., and then bolted together. I next marked out and drilled the holes for the main jet boss, throttle bosses, and strangler lug; after this, I carried out the machining of the section for the body and fixing flange. This flange is circular to allow for any type of fitting, vertical, horizontal, or angular.



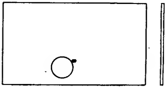
3—Base-plug.

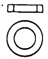


Vented plugs.



11—Clamp plate.





8, 9, 10.

12—Clamp plate.

then parted the die and milled the recess for the throttle stop, and also, I milled away the metal between the hole I had drilled for the strangler lug and the main bore. I then turned a base plug as shown in the drawings, after which, attention was given to easing away the sharp corners, and also running an appropriate size of taper-pin reamer into the holes forming the main jet and throttle bosses, all of which was done from the joint face side of each die half, only sufficient metal being reamed away to form a clean taper for the length of the holes. This was followed by drilling and cutting the necessary vents ; then I turned and vented the plugs for ensuring that the throttle and main jet bosses were cast a reasonable length so as to eliminate excessive machining. To keep these plugs in position, a piece of 20-gauge steel plate was used on each side as shown, care being taken when assembling to ensure the vents on the plugs pointing towards the top of the die. Before use, the two halves of the die were smoked, also the base plug ; the two halves were then bolted together, with the plugs in their correct positions. I then heated the die, together with the base plug, in preparation for casting. When all was ready, including the ladle of molten aluminium, I placed the base plug on the asbestos mat, and put the die over it. I then proceeded by taking the ladle of molten aluminium, and using a length of $\frac{1}{4}$-in. diameter steel rod to encourage the metal to leave the ladle lip, I filled the die. After a wait of a few minutes, I unbolted the die, removed the base and boss plugs, and then parted the die and extracted the casting ; it proved to be another winner !

In conclusion, I should like to add, that, if any reader requires further information about the dies, I shall be pleased to attempt to furnish it if readers will write to me *via* the Editor.

[We have inspected a set of castings produced by Mr. Callis in the manner he describes, and we find them excellent in every way.—Ed., " M.E."]

Two Improved Workshop Aids

(*Continued from page* 126)

addition is the flywheel pulley on the worm spindle, which gives a good reserve of power on heavy cuts. Using this milling-head, 32 diametral pitch gears, $\frac{1}{2}$-in. face width, of 3 per cent. nickel steel, have been cut at one pass in 15 seconds per tooth.

The attachment was originally driven by an overhead gear in which the belt tension was maintained by means of a weight and lever. It was found that during cutting, the belt had a tendency to kick and slip. This was cured by using a tension-screw and nut to keep the take-up pulley shaft in a fixed position, and the belt under a constant tension.

*Garden Railways

By R. R. HOOD, A.M.I.Ae.E.

Track Laying and Maintenance

WHEN a piece of ground has been duly levelled, you lay the ballast and, to get it level and uniform in thickness, you drive in two rows of pegs which project $2\frac{1}{2}$ in. above ground. The pegs are 3 ft. apart along the track, and 18 in. apart across the track. The tops of the pegs are levelled-up with the spirit level.

You now tip a bucketful of ballast between the two rows of pegs about every 3 ft. and smooth it down with a board until it is evenly distributed and level with the tops of the pegs. This requires a little skill which is, however, quickly acquired. In a short time, you will have a surface equal to a lathe-bed as regards level and straightness. You then fetch a section of made-up track and merely place it in position; it needs no fixing, because the unplaned sleepers grip the ballast by friction. Another section of track is then joined up, a spare sleeper being placed under the joint, and the flat fish-plates put into position and screwed down. The width gauges are used when doing this, in order to bring the ends of the track to the correct 5-in. gauge. Don't forget to allow the $\frac{1}{16}$-in. expansion-gap between each section.

Now tip some fine ballast on to the track and brush it between the sleepers until it is flush with the top and all clean and tidy. I have laid ballast, *made* 12 ft. of track and laid it in one evening of $2\frac{1}{2}$ hours; but it takes a long time to write about it. Occasionally, sight the track from the end to see that it is straight; it will, of course, be level if you have laid the ballast properly. Sighting the straight track by eye is useful, but highly critical. In the cutting the curved track cannot be sighted except by placing two or three straight-edges across the track. These should be at least 3 in. high, and by " standing on your head " you can see across the tops and detect any " wind," or rise and fall, quite easily. When laying the curved track in the cutting, you keep it central by eye, and if you have made the cutting reasonably true to curve and have also bent your track to the correct radius when making it up, you will find that it all works out O.K.

The track joints are a slight snag on the curves because, when you bring two sections together, you will find it necessary to cut about $2\frac{1}{2}$ in. off the inner rails; this is done " on site " by holding a saw blade in a hand vice.

Running Test

First obtain a *flat* piece of board 12 in. wide and 24 in. long $\times$ 1 in. thick. This is used to test the flatness of the track by pushing it along the rails and repeatedly trying it for " rock." A 6-in. level put crosswise thereon will show which way the errors are. Correction is simple, you merely lift up the low end of the offending sleepers until the board ceases to " rock." This is quickly done, a 100-ft. run taking about a half-hour to check.

Super-Elevation

The super-elevation is only $\frac{1}{2}$ in. at the ends of sleepers on the curve; this is only about 1/3rd of the theoretical amount, but is enough and prevents other troubles where the curve joins the straight. This super-elevation is achieved by using the test board, on which the spirit level is packed up to suit. The outer rail is then lifted until the level gives a central bubble, additional fine ballast being used to hold it there. See that you do not get any " rock " on the test board at the point of junction between curved and straight sections; the super-elevation should fade out gradually into the " straight," where a slight inevitable " rock " won't matter. When O.K., load up a wagon with one brick and give it a shove to send it careering down the " straight " and round the curve. If O.K., do it again, this time at twice the speed which the locomotive and train will ever reach. If all serene, fill up with bricks and push the truck around a few times to iron out the track. Then get aboard your bogie truck and paddle yourself round on it. It will run silently and without sway and you will be more than pleased with the result, the ballast giving the effect of a track laid on a thick carpet.

Adjusting Locomotive Springs

Now push the engine round and watch the wheels. My engine threw its rear coupled-wheels off when pushed slowly round the curve. This is nothing to get

**Continued from page* 106, " *M.E.*," *February* 1, 1945.

excited about and merely indicates that there is not sufficient weight on the rear wheels. The engine was run back to the "pit," *i.e.* the "elevated" portion, where two sleepers have had their middles cut out to permit one's hand to reach under-gear. The rear spring nuts were then tightened up three-turns and the wheels remained on the track after that. During several years of high-speed running, with several types of engine of friends and my own, NO de-railment has ever occurred. Inspect the track for twigs, stones, etc., before running. The locomotive requires "guard irons" for safety's sake.

Several railways in this country employ track oiling on the outer rail of curves. In the U.S.A. they smack grease on; even so, they get long slivers of steel torn off the track on some sharp curves. The oil is put on the inner face of the rail, not on the running surface. In Germany, they employ drip feed on to the wheel flanges.

Buffer Locking and Buffer Stops

Buffer-heads need to be 2 in. diameter; the "scale" fans will "cry" over this, but there it is. The engine buffers can be normal, but those on the truck must be big.

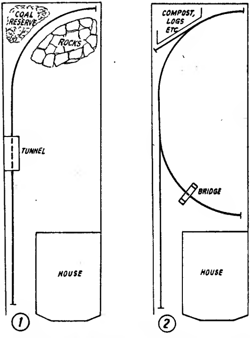
The end stops are not fixed to the track or elevated structure, because they tend to shift the track or strain the structure; they merely "float" on the track. The arresting stress is taken by tie-rods suitably anchored. The springs are old M/C fork springs and will stop a ¼-ton train doing 2 m.p.h. in 3-in. travel without damage.

Transition Curves for Backward Trip

In a previous letter, I mentioned how a long express type locomotive can be persuaded to negotiate fairly sharp curves. It is often overlooked that the accepted formula for arriving at minimum radius is not complete in itself, *i.e.* a 4-6-0 type engine can be designed to negotiate a certain sharp curve *if placed on* that curve. It will even run from the straight line on to such curve when travelling chimney first, but will *not* do so when running tender first. The return trip on my line is done in reverse, therefore, a "transition" (easy) curve of twice the normal radius is introduced where the straight meets the curved portion. This permits the bogie to get swinging gradually in readiness for the sharp curve which follows, and prevents the front of the engine fouling the bogie as the former swings across. Think it over and draw it on paper —you'll be surprised.

Elevated Portion

When the track reaches a place where the ground falls away so rapidly that an earth bank is no longer desirable, you commence the elevated structure like a bridge. This portion is also convenient for attending to the locomotive and for getting on to the train—You can make a "station" of it if you wish. Concrete posts are cast in a box, which should be greased inside. Two pieces of wood, 1 in. thick, are fitted to reproduce two ledges on the post for the bridge boards to rest on. A tube, 1 in. diameter, is pushed through two holes in the box and creates a cast hole in the post through which later a ¼-in. bolt passes to hold the boards which support the track. The posts should be 1/3rd of their length in the ground and cemented in. The procedure is to stretch a



Layouts for long, narrow gardens. Radii of curves = *width* of garden or more, to suit type of locomotive.

horizontal string from the existing track and drop the posts into holes and line them up. The boards are 4 in. × 1 in., set on edge 4 ft. apart. Ends of adjacent boards are merely butted, the bolt passing through the posts and between notches cut in each end of board and clamping all firm, *via* large washers. The boards do not rest directly on the steps on the posts because a ½-in. thick tapered wedge is interposed to permit final levelling. The object of a ¼-in. bolt in a 1-in. hole is now obvious. The sleepers are placed across the two boards, every fourth sleeper being nailed down. The posts are 6 in. ×

4-in. section and 4 ft. apart; their design and spacing depends upon what boards you can get. Mine were old packing cases.

Tunnel

When built, this will have proper concrete ends, but the tunnel part will be a "D" tube of old lino camouflaged with paint and shrubs. In the event of "smash up 'int tunnel" you merely stand up (if not knocked out!) and the lino will come away resting on your head; otherwise, you will need a gas-mask if you wait until someone finds you and drags you out.

Accidents

If the P.W. Department do their job there won't be any accidents; but, whereas your own children will, or should, accept a little injury in a philosophical manner, other people are apt to take a poor view if their little angels are returned to them minus one ear through testing the abrasive qualities of concrete therewith. One should really either insure or get a clearance from the parents on this point. There is no difficulty in balancing oneself in the lying down attitude, even on $2\frac{1}{2}$-in. gauge. "All Elevated" tracks do not cure everything either. The only accidents I have seen were on elevated tracks, but they could have been avoided.

Layouts for Long, Narrow Gardens

Some gardens are very narrow, and sketches are given of suitable layouts for such gardens; or you can copy mine and build a locomotive of the 0-4-0 "Peckett" type, which makes a very handsome engine.

Passenger Trolley

8-wheeled bogie, 4 ft. long. Wheels $3\frac{1}{2}$ in. diameter, loose on axles. Large wheels give smooth running. Loose wheels reduce friction from "slip" on curves. The "slip" is $2\frac{1}{2}$ in. in every 6 ft. if the wheels are fixed. Plain bearings are used, but they are properly lubricated, the oil being introduced at the point of negative pressure, as it should be. No springs are used, the bogies being equalised and bolted to the wooden top with some old rubber sheet interspersed. The wheel flanges should have slightly more lean-back angle than usual to reduce rubbing on curves. Flange depth is only 5/32 in.

The Effect on the Garden

Even those who hate railways have now emphatically agreed that this one has considerably improved the garden and added a peculiar charm to it. A simple footbridge has been built in one place to reach a portion cut off by the track. Every part of the garden comes under the eye during track inspection and everything is kept tidy, which was not the case before. When driving the engine, one gets views of the garden from an unusual angle, which greatly adds to the charm of the whole thing. Some facetious friend asked me whether this "article" was for an engineering paper or some gardening journal; but it's a poor individual who can only use a lathe to the exclusion of everything else, and I would remind the "super-scale" fans that prizes are awarded for the best station gardens by several Railway Companies.

Scenic Effects

Any locomotive, whether "O" gauge or $7\frac{1}{4}$ in., looks better in proper surroundings, but you must use your own imagination here. Use can be made of little trees, particularly the conifer called Retinospora which takes readily from "cuttings," and, by using baby ones in the distance, with large ones in the foreground, will give a "perspective" effect. Trees can be painted on the fence in places if desired, they remain visible for years, even with the cheapest paint. From a distance of 50 ft., you cannot tell which are alive or which are "painted." There's nothing in it; have a look in the local picture shop and you can learn all the art you need, in ten minutes.

A Few Final Hints

Creosote the sleepers and woodwork every summer, the little drop that runs off the sleepers kills most of the weeds. Don't *clean* the track, it causes wheel slip. Clean the truck wheels; otherwise, the running becomes lumpy.

Rain causes erosion of the bank, in time; so make up the sides once in two years with extra earth and stones.

Total maintenance does not take two hours per month.

Don't run during wet weather, let the ground harden.

If you feel a defective portion when running—throw a piece of coal or wood overboard and go back and look for the spot thus marked.

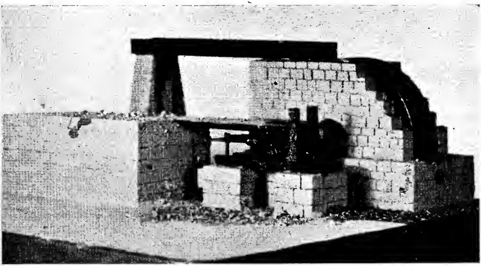
A spirit-level 60 ft. long is a useful tool and merely consists of the garden hose filled with water; a piece of glass tube, or a tundish (funnel), stuck in each end enables you and an assistant to see the water level.

Alternatively to the "sighting board," you *can* use a gun with a spirit level on the barrel. If the barrel is a tapered one, you must pack the level to suit. "Toolmakers" will know all about it.

I should like to thank those who so kindly appreciated my previous letter, particularly the gentleman in Calcutta, and my lady assistant, who so expertly handled the concrete like a born navvy!

A Pair of Rolls

Mr. F. D. Woodall produces a most unusual miniature.



ONE of my interests during the summer months is to cycle to some of the old mines in North Yorks. It is only rarely that I see anything of purely mechanical interest. One of the exceptions is at Old Providence mine, near Kettlewell, where last year I saw a derelict mill for crushing lead ore. This model is not a copy, but shows the essential features for one pair of rolls, whereas the Old Providence mill has a pair on each side of the 21 ft. diameter water-wheel that drove it.

The rolls are held in contact by a system of levers and weights, thus if a piece of tramp iron or other obstruction were to enter the rolls, one would be forced away.

On the original, nearly all the woodwork is rotted away, so the manner of feeding the mill is a matter of conjecture. In the model I have built a small platform and chute over the rolls.

Unless it were part of a large scenic layout, a model of this type has to be somewhat incomplete; as can be seen, the launder for bringing water to the wheel stops short at the left-hand side, as also does the raised-up part where the wheelbarrows of ore would be brought to.

A small electric motor enables the model to be shown running.

Here are a few dimensions of the original: wheel shaft, 6 in. square; roll shafts, 4 in. square; both coupled together by 10 in. square muff couplings; rolls, 15 in. diameter, 18 in. wide.

The Chingford and District Model Engineering Club

THE above club was formed by a group of enthusiasts who met on January 13th to discuss the possibility of its formation. A chairman and officers were appointed and a committee elected to prepare a programme, and they extend a cordial welcome to all model engineers in the vicinity to join. As soon as the probable membership is known, they can proceed with negotiations for a club room, workshop, locomotive track, etc. The words "and district" have been deliberately included in the title in the hope that anyone who is in any way interested in model engineering, on land or water, or in the air, and who live in the adjacent neighbourhoods of Walthamstow, Leyton and Leytonstone, Wanstead and Woodford, Buckhurst Hill and Loughton, will come forward and make this club a success. Mr. L. Mills, of 2, Fairlight Avenue, E.4, who called the first meeting together and is, therefore, the instigator of the club, has consented to act as Hon. Sec. *pro tem.*, and intending members are requested to get in touch with him at that address. It is intended that the club shall be run with the minimum of formality and the maximum of companionship, so—come along, you "lone hands" and help to make it a success.

*Experiments in Four-stroke Engine Design

By EDGAR T. WESTBURY

A review of several years' efforts to improve the breed of model petrol engines for speed-boat propulsion and other purposes

BOTH the shape and dimensions of the flywheel for the "Kittiwake" engine (Part No. 3, illustrated in Fig. 33) are subject to modification to suit circumstances of installation, or available material. A cast-iron flywheel has been employed quite successfully on several of the engines built to this design, but many authorities are dubious about the safety of this material at very high speeds, and mild-steel is certainly better in this respect if it can be obtained. One potential risk in the use of a casting is that it may not be perfectly homogeneous, and apart from the reduction in strength which this may cause, it also affects the distribution of weight, and, therefore, the balance. There is always a possibility that the casting may contain quite large blow-holes, and unless these are exposed during machining, their presence cannot be detected without an X-ray test. I have sometimes found large cast flywheels to be badly out of balance after machining all over, although apparently quite sound ; and for this reason, a static balancing test (dynamic balancing would be better still, but methods for carrying it out are not generally available to the amateur) is well worth while.

In some cases it may be advisable to taper or bevel the edge of the flywheel in order to enable the engine to be placed as low as possible, and at a convenient angle, in a flat-bottomed boat. A larger diameter flywheel, or one having more mass in the rim, is desirable if the engine is to be run at speeds less than that required for racing—say, not more than three or four thousand r.p.m.—or if it is required to have a wide range of speed control. The necessity for keeping down weight in a racing power plant, however, limits the permissible size of the flywheel in most cases.

It will be seen that the centre of gravity of the flywheel is brought as close to the engine as possible, a condition I consider highly desirable in any high-speed engine, on the grounds of sound mechanics. By making the starting pulley integral with the flywheel, its hub is stiffened considerably, but this feature is optional, and it may be found preferable to fit a ratchet pulley or other convenience for starting. The pulley groove is deep enough to enable either of the two alternative popular methods of starting to be employed—that is, either several turns of fairly thin cord, with the end suitably anchored to a hook or notch in the pulley, or half a turn of large diameter belting, gripping the sides of the pulley by friction. Personally, I favour the former method, having never properly mastered the technique of belt starting.

One important factor in the success of the latter method is that the frictional grip of the belt should be sufficiently tenacious to turn the engine against compression without applying excessive side pull. This will obviously depend very largely on the angle of the pulley groove, and it may be observed that many constructors make this too obtuse to ensure a proper grip, particularly if the belt is wet or greasy—which is rather the rule than the exception, in model speed

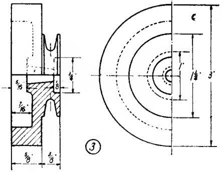


Fig. 33. Flywheel details.

boat practice. I have not specified any precise angle for this groove, but as drawn, it is about at an included angle of 20 degrees, which I have found to give a good working compromise between slipping and jamming of the belt.

Opinions among model speed-boat constructors are divided as to whether the engine should be installed with the flywheel at the forward or the after end. There is no doubt whatever that, from the purely mechanical point of view, it is most desirable to have the flywheel at the driving end of the shaft, and, in large engines, this condition is sometimes absolutely essential to avoid torque vibration, with its attendant mechanical troubles. In a speed-boat, it is also desirable in order to keep the centre of gravity of the engine as far aft as possible ; but, on the other hand, it may often

**Continued from page* 84, "*M.E.*," *January* 25, 1945.

necessitate raising it too high, which, in turn, involves too steep a propeller shaft angle. I cannot say that I have ever encountered any engine trouble directly attributable to torque vibration, but it is by no means uncommon for crankshafts to be badly wrenched by fouling of the propeller or seizure of the tail shaft. However, many consistently successful boats—in which I may perhaps be permitted to include my old stager *Golly*—have had the engine fitted with the flywheel forward. Incidentally, this position also favours the efficient cooling of the sparking-plug and ensures proper oil drainage and submersion of the oil pump.

In machining the flywheel, the most important points are to ensure that its seating fits the tapered end of the crankshaft properly, and that it runs truly all over. My usual method of dealing with this job is, first, to chuck the casting by the inside of the rim, and rough out all accessible surfaces, including the pulley and the outside of the rim. It is then reversed, and all the back and inner surfaces machined, including the drilling and boring of the hub. Finally, it is mounted on a taper mandrel for finishing all exterior surfaces.

Methods of boring an accurate internal taper have often been described in THE MODEL ENGINEER, so I do not propose to deal with them here, except to stress the importance of a proper fit over the full length of the taper. Do not imagine that inaccuracy in this respect can be corrected by lapping or "grinding in" the flywheel on its shaft; it is much better, if one's best efforts fail to achieve perfection in straight machining, to fit the shaft with the aid of a fine file, sparingly and judiciously employed on its tapered end. Use a fine smear of coloured marking to check accuracy.

While the flywheel is on its mandrel for final finishing, it may be statically balanced by running it on parallel and carefully levelled knife-edges. Steel rules or dead-straight hacksaw blades can be used, clamped to suitable packing blocks, and the mandrel should have rolling surfaces of equal diameter turned on the two ends. In the event of any error of balance, it should be corrected by drilling the *inside* of the flywheel rim.

Piston (Part No. 4)

The shape of the piston crown shown in Fig. 34 is suitable in an engine of moderate compression ratio, but is subject to modification, and I have come to the conclusion that there is scope for a good deal of experimental work in finding the best shape for the piston crown in individual cases. A comparatively flat, or even concave, crown

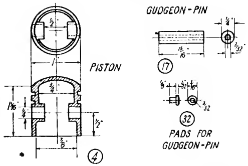


Fig. 34. Piston, gudgeon-pin, and end pads.

produces a more efficient combustion space, but seriously limits the compression ratio, and there is some doubt whether the type of head associated with, and almost inseparable from, the use of inclined valves, is really suitable for compression ratios much above 8-to-1. I have formed the opinion that making the piston practically a "plug gauge" fit in the head, and scooping out clearance spaces for the valve heads, in order to obtain super-high compression, is definitely not efficient from the thermal or any other point of view. The fact that it is often done in full-size practice does not signify, as the cooling effect of the metal surfaces adjacent to the burning gases influences the flame propagation much more seriously in the case of a small model, owing to the increased ratio of surface to volume.

If I intended to use a really high compression ratio, such as 12-to-1 or over, which is often considered desirable when using "fancy" fuels, I should prefer to use a flat cylinder-head with vertical valves, despite the limitations which the latter impose on port area and passage design. But the general user of small petrol engines in normal speed competition work may find that the most satisfactory all-round results are obtained with "straight" fuels and moderate compression ratios, if my own experience in these matters is any criterion. It takes quite a lot of time and patience to get results which justify the use of special expedients of this nature, and often in practice, their only noticeable effect is to make a docile engine temperamental. But some of my more advanced readers may have very different ideas on these matters, and if so, I beg them to come forward, not with destructive criticism or high-faluting theory, but with some practical information. I am not ashamed to admit the limits of my own knowledge, but I do know that several clever tuners of dirt-track motor-cycle engines have failed to get their methods to

work when applied to model engines. It is one thing to handle a temperamental engine when one has all its controls to hand, and quite another to pre-set them so that the engine does its best under violently changing conditions.

However, the important thing to remember is that the shape of the piston has an important influence on combustion efficiency, and that one shape is not necessarily correct for different compression ratios. Thus the practice, which I plead guilty to having adopted in the past, of keeping a set of compression plates to fit under the cylinder base for experimenting with different compression ratios, can hardly be considered ideal; not only the height, but also the shape of the piston crown may have to be found experimentally, to obtain optimum results under particular conditions.

Piston clearance is not quite so important in a four-stroke engine as in a two-stroke, but I do not believe in the common idea that "the sloppier it is the better." Thrust pressures of considerable magnitude are set up on the sides of a piston in a high-performance engine, and if it is to be considered as an efficient crosshead, there is clearly a strong case for providing as large an area of contact surface as possible. A piston which has a large clearance can only make contact over a narrow strip of its surface, unless it is carefully hand-fitted to conform to the cylinder-wall curvature, and even then it is difficult to maintain a proper oil film if the piston shifts over bodily with alternating thrust.

It is, of course, essential to provide sufficient piston clearance to cope with the maximum thermal expansion of the piston, and ordinary aluminium alloys expand much more than cast-iron; also, the crown gets much hotter than the skirt, so that greater clearance should be allowed at the top than at the bottom. I recommend in a cylinder of 1 in. bore, about 0.006 in. clearance at the top land, 0.004 in. between the rings, and 0.003 in. at the skirt, but careful running-in of the piston is necessary, as it will almost certainly "grow" and distort to some extent in the early stages; it may be necessary to watch carefully for the development of high spots, and ease them off with a dead smooth file when they arise. It is also desirable to relieve the sides of the piston, in the region of the gudgeon-pin bosses.

Finer clearances than those specified can be used with special low-expansion piston alloys, but these are not easy to obtain at present, and some of them do not machine at all easily with ordinary tools. If a casting is not available for the piston, it may be difficult to machine it internally to the shape shown in the drawing, and, in consequence, its weight will be greater, and may have to be allowed for in balancing.

The piston rings are lower down and farther apart than is usual in small engines, as I have found that this makes for cooler running and improves oil control. It is hardly practicable to fit special oil control rings, even if it were possible to obtain them in such a small size, and any special form of ring which might cause increased friction is undesirable.

For machining the piston, I recommend the use of a turning jig. The usual piston turning jig incorporates a spigot which fits inside the skirt, and a draw-bolt which pulls either on the internal bosses, or on a temporary pin through the gudgeon-pin holes. To avoid the necessity for making a complicated jig, the latter method is usually preferred, but it obviously involves the necessity for boring the gudgeon-pin holes before finishing the external machining of the piston.

A simple jig of this type is shown in Fig. **35.** It can be made from any odd piece of material large enough to form the spigot to receive the piston and the narrow shoulder against which the edge of the latter abuts, and in cases where it is not necessary to dismount and re-chuck the fixture, can be machined and used *in situ* while mounted in the three-jaw chuck. It is drilled and tapped centrally to take the draw-bolt, which has a cross hole to take the temporary pin by means of which the piston is secured. When the pin is inserted and the piston is turned by hand, the latter will be drawn up firmly against the shoulder, and centred by means of the spigot in the skirt.

To adapt this simple device for repetition work, the body may be made to screw on the mandrel nose, and the draw-bolt extended to pass right through the lathe mandrel, like the draw-in spindle of a collet chuck; but the form shown is quite effective when only one piston has to be dealt with, and very easy to make.

It may be added that the practice, sometimes adopted, of simply making a plug mandrel and fitting the piston to it by friction, is not highly satisfactory, because if the latter is tight enough on the mandrel to hold really securely against machining, it will be expanded so that the finished measurement of the skirt is fictitious; and there may also be some difficulty in removing it from the plug when finished. The method illustrated avoids any possible distortion of the lightest piston.

In this case, the procedure for machining the piston is as follows: First hold the casting in the four-jaw chuck, skirt outwards, by the chucking-piece, if provided;

or if not, by the head end, with as much of the skirt projecting as possible. Set it up so that the cored internal surface runs truly, *entirely disregarding the truth of the outside surface*, then face the end to finished length, measuring from the centre of the internal bosses, and bore the skirt to fit over the jig spigot, and as far in as the bosses allow. Rough-turn the outside, or as much of it as is accessible, and before removing the piston from the lathe, mark out the gudgeon-pin centres on both sides, using a scribing block on the lathe cross-slide, with the scriber point set exactly at centre height, and checking off the angular position of the mark from the internal bosses. The height of the gudgeon-pin centre can be measured directly from the end of the skirt, or by depth gauge from the boss centres. Care in checking both these positions will ensure that the holes, when bored, will pass right through the centres of the bosses.

piston from the boss centres in this way, centring the front mark does not necessarily ensure that the hole will pass centrally through the rear boss or on the true diametric centre of the piston. From the purely mechanical point of view, the important thing is that the gudgeon-pin should be square with the plane of piston travel ; an error in the central position of the pin is not so serious, and it may be of interest to note that in certain cases, gudgeon-pins have been placed deliberately out of centre, with the idea of reducing connecting-rod angularity on the pressure stroke, thereby in turn reducing side thrust on the piston ; or minimising piston slap.

The piston may now be chucked head outwards on the jig, using a temporary gudgeon-pin well below the finished piston diameter in length, and the machining of the head and exterior surface finished. In turning the ring grooves, the important point is to finish

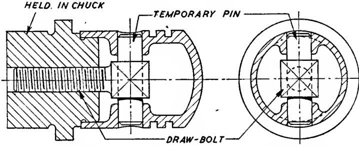


Fig. 35. A simple form of chucking-jig for final machining of piston.

To ensure perfect squareness of the gudgeon-pin with the piston axis, the orthodox method is to set up the piston on an angle-plate, mounting the latter on the lathe face-plate. If the piston is held by means of a strap over the head, with bolts on either side, there is not much risk of distorting it, and in this respect, this method is better than using a vee angle-plate. The chucking-piece, having served its purpose, may now be cut off, and its stump filed reasonably flat to form a bearing pad for the strap. In order to ensure that the transverse centre line of the gudgeon-pin bosses is parallel with the lathe axis, a line should be scribed plainly across the angle-plate, square with its back surface, and the piston placed so that its centre line, front and back, coincides exactly with this line. This may be done before attaching the angle-plate to the face-plate, so that the lines are clearly visible ; the piston is then set up, by shifting the angle-plate bodily on the face-plate as required, until the gudgeon-pin centre runs truly in both planes.

Unless care is taken in squaring up the the sides of them accurately and smoothly, and for this reason I do not recommend attempting to form them the full width at one cut. Apart from the liability to chatter, there is always a risk of scoring the side faces when this is done. The tool used should be narrower than the ring, and have cutting clearance on the sides, so that side cuts can be taken after running the tool straight in to a depth two or three thous. of an inch greater than the radial thickness of the ring. Fit the latter with just sufficient side clearance to avoid jamming, and no more, as excessive side clearance results in poor oil control, and hammering which may eventually lead to breakage of the ring.

I have always recommended the use of ready-made piston rings, when they can be obtained, but as this is very difficult at present, and many readers wish to make their own piston rings, I cannot do better than refer them to the excellent article on this subject by Mr. Ian Bradley in the issue of THE MODEL ENGINEER dated October 22nd, 1942.

The inside faces of the piston bosses may

be faced by means of a facing cutter made to fit a ¼-in. spindle, and capable of being placed in position and secured by a grub-screw after the spindle is inserted. A very simple cutter, with as few as three teeth, works just as well as the most elaborate cutter, so long as care is taken to see that the tooth face is square with the bore. If desired, a double-faced cutter, with right- and left-handed teeth on the respective faces, may be made to save the necessity of reversing it after one boss has been faced. The distance between the bosses should allow a little side play of the connecting-rod small-end, to cope with any possible error of lateral alignment of the piston and crank-pin centres.

Gudgeon-pin. (Part No. 17)

This is a perfectly straightforward component, which may be made from mild-steel and subsequently case-hardened. Alloy steel is generally used for gudgeon-pins in full-sized practice, and is superior in strength to mild-steel; but unless correctly heat-treated, it may be either too soft or too brittle, so that the amateur constructor will be well advised to avoid it. If, however, it is possible to use high-tensile steel to full advantage, the hole through the gudgeon-pin may be a good deal larger than the 3/32 in. diameter hole specified, and reciprocating weight thereby reduced. The pin should be fitted on the tight side to the piston bosses, as they will loosen with the expansion of the latter when hot.

Soft pads of brass or aluminium alloy (Part No. 32) should be made a light press-fit in the ends of the gudgeon-pin, and their heads smoothly rounded off so that if they touch the cylinder walls they are not liable to cause scoring. The length over the ends of the gudgeon-pin, with the pads fitted, should be about 1/64 in. less than the cylinder-bore diameter, so that under no circumstances is it possible for endwise jamming to occur.

General Information

I would like to emphasise that, although this detailed description refers to a particular engine design, I am doing my best to make the information applicable to other model petrol engine construction problems. Many of the queries I receive relate to details of design and machining methods, and careful study of these articles should help to forestall such queries, whether the reader wishes to build a "Kittiwake" engine, an engine to some other published design, or to design one entirely off his own bat. My policy is to help readers to help themselves, and it is my opinion that stereotyped "one-track" descriptions, applicable only to one design of model, are very limited in their usefulness to constructors who, in more cases than not, wish to modify standard designs, or exercise their own ideas in any models involving similar problems.

(To be continued)

Letters

Shapers, Millers and Lathes

DEAR SIR,—I have followed with interest the various articles and letters concerning the merits of millers, shapers, and the universal model maker's lathe. It would appear that we model makers are inclined to get off the rails in the heat of these arguments, since both miller and shaper have certain functions to perform, and it depends therefore on the type of work that a model engineer specialises in, as to which machine he should buy.

Admittedly, a simple power shaper is somewhat easier to manufacture than a miller; reference to THE MODEL ENGINEER of February 16th, 1905, will show what could be produced *then* by Leyland, Barlow & Co., a self-acting bench power shaper; perhaps some of our older readers had experience of it. The present-day Alba 1A shaper, selling at about £60, is a toolroom shaper in miniature; it requires only ½ h.p., and it has all the refinements. As for millers, there are plenty of bench millers requiring ¾ to 1 h.p. in use in war factories using standard cutters on a 1-in. arbor; the only snag is that all movements are by hand, usually lever type. The finest small miller I have ever come across is Tom Senior's; it is indeed a small toolroom job, was reviewed a year or two ago in THE MODEL ENGINEER, and is self-contained, the only useful thing missing is the drive for a dividing head to mill spiral jobs, and swivel table; these are super-luxuries for the model engineer. Out of a whole stock of millers in our works, this is easily the most popular with both the setters and toolroom people. Would Mr. Senior consider simplyfing it a little for the home user and so get the price down; say cut out the suds pump and auto electrical gear, also the auto belt shifter? If you want to make press tools, then the shaper has it; but for locomotive work—well, the miller, obviously!

As for lathes, what is wrong with the South Bend, Atlas, Milnes, and Drummond? All will agree that they are what are wanted, but perhaps the price is too high. Well, those who grumble should think again at the

work in these excellent machines. We hear calls for hefty headstocks, which seems to indicate that a larger lathe than $3\frac{1}{2}$ in. is wanted, say, $4\frac{1}{2}$ or even 6 in. with a short bed of, say, 5 ft., quick release tailstock too, and extended aprons to the slide or boring table. I have used a Norton Ace 8-in. lathe (German make) quite a lot and have found it a beautiful lathe, but not able to take a cut comparable with English orthodox lathes of equal size, due to its multi-speed headstock gearbox. I know it cost about £300, but I would prefer it to any other in my shop. It is not too big to do even $\frac{1}{2}$-thou. jobs with a collet attachment for weeny little bits and pieces.

We want something better than the cheap types of lathe, which all appear to have the same patterns as a base of approximately 3-in. centres, with that tailstock that requires a spanner to shift, also a clout on the head of the nut to release the clamp, a top slide that shifts under a *cut* (self-act at a fine feed); not the quick traverse with a 60-tooth wheel on the lead screw, but on small lathes vee-belts from headstock to countershaft are essential. I find that under a decent cut the flat belts usually start to slip, but one could go on and fill a page with objections and wants, and we should still not find the acme of perfection, since every model maker wants different things, according to his taste, abilities, and what he is prepared to pay out.

I want a large hollow mandrel and a Taylor self-centring chuck that is really accurate. I can hear murmurs about cost again; but, after all, our time is short enough and we want to get on with our model making without struggling with indifferent tools amid much sweat and "esperanto."

So it appears to me that we cannot expect the trade to produce that wonderful lathe-cum-everything-else at the price of £15 to £20. The solution is for all makers who have catered for us before to pool their resources, produce a sound standard lathe, and sell it in bits and pieces without putting fabulous extra charges on all the refinements that we want to buy as we need them.

I cannot pretend to give a full outline of the idea in this space. So, please let all who rush to put pen to paper to disagree with someone else remember that every model engineer has different circumstances and aims in his hobby. There may still be a market for a simple cheap lathe for those of us who are not too well blessed with this world's goods, who nevertheless want to enjoy the king of hobbies, but please, Mr. Manufacturer, let it be accurate and actually easily usable.

Yours faithfully,

Darwen, Lancs. "HAD SOME."

The Lathe Question

DEAR SIR,—The recent correspondence concerning the model engineer's lathe has interested me very much; I am one of those people who earn a living by lathes, and our works here has an excellent selection of modern and not so modern machines. Although we do a lot of rather fine instrument work suitable for machines $3\frac{1}{2}$-in.-5-in. centre, I have found the average small machine offered to the model engineer a hopeless failure, whereas the American type of machine is an excellent proposition. I think it is about time the British manufacturer forgot about flat beds, mandrels with 1-in. Whit. noses and tiny bearings, tailstocks which have no location on the bed except that maintained by a tongue fitting between the ways of the bed. This tongue must be free enough to slide when the machine is new; a short spell of usage and it is free enough to rattle. Curiously enough, the makers of one of our cheapest lathes have paid attention to this point, while on the other hand I have seen a rattling tailstock on a new £300 $6\frac{1}{2}$-in. machine (and the operator's comments were worth hearing!).

I consider the chief failing of the flat-bed machine is the stiffness of the saddle which develops as soon as the machine is used, especially if the material is brass or cast-iron. Once a little swarf has got between the saddle and the bed, and felt wipers or pads are only a partial preventative, gone is any sensitivity to hand feed, so necessary often on small work. The vee-bed does not suffer from this fault to any great extent, and the saddle remains light and free with little attention.

Recently, however, quite a number of British machines have been made of similar type to the "South Bend" workshop lathe, and I think that in post-war times the model engineer should have a choice of some excellent machines. There is, for example, the "Challenger" 5-in., a lathe on purely American lines. We have "caned" one of these for over four years now, and it is still as good as new; I suppose it has done work the equivalent of generations of model making.

There is also the "Bantam" 5-in. lathe, made by the Colchester Lathe Company. This is one of the sturdiest 5-in. machines (of the belt driven type) made and, at the same time, is one of the cheapest. I believe the price was about £32 pre-war, and it could always be seen at the Exhibition on the stand of one of our tool firms. The workmanship on this machine is of the highest order, and the general performance is well ahead of the lighter American examples. On my frequent visits to the Exhibition I

have not seen model engineers display much interest in it; perhaps it appeared just a bit too heavy, an excellent "fault."

The average model engineer would be well advised to spend as much as possible when purchasing a lathe. I can think of no tool that can give so much, or so little, satisfaction. A good tool is a joy worth having, a poor one can never be more than a disgust, and I think that poor lathes have turned quite a few of us away from the hobby. However, as so many in our ranks have been using good tools on war work, I believe the future model engineer will be rather critical when buying himself a machine, and will hardly be satisfied with an antiquated design. I can assure him that the American type of machine, if he desires this type, will be obtainable from British makers, and will give him lasting satisfaction.

I should like to relate a tale (true) which, I think, deserves a paragraph.

Along with another engineer, I entered a large machine tool premises in Glasgow, to purchase a heavy drilling machine. We at once noticed two really antique lathes, and, much amused, went up to have a look at them. To our surprise, they were not at all antique; in fact, it was obvious that they had just left the works, and from first to last they were examples of really good workmanship. But, the design, 1870 or thereabouts. There is no doubt about it, we do have some most conservative lathe makers!

Yours faithfully,

Stirling. JOHN MACKAY.

"An Old Timer"

DEAR SIR,—I have read with great interest Mr. Victor B. Harrison's article in THE MODEL ENGINEER for January 4th, under the above "heading." Recognise her? I should think I do! I was a "Penny-a-week" schoolboy when I had Bassett-Lowke's catalogue containing the description of this engine as set down by Mr. Harrison.

They were good locomotives for those days, their appearance only being marred by the somewhat "scanty" number of spokes in their driving wheels and the S/V being perched on top of the "Ramsbottom" casing.

Talking of other early commercial models, I wonder if any "old boys" remember or have in their possession any of the following—to wit—the 2-4-0 "Pilot," the North London Tanks, the early type "Black Prince," the old "King Edwards" (sold by Gamages).

The models, although boasting of S/V cylinders, were not fitted with lubricators or superheaters. The "starting valve" on same was placed on the steam dome; later on front of S/B (hand-wheel), and finally in cab. The eccentrics were outside the wheel boss, and a piece of gauze protected the boiler from the old wick lamp. The old catalogues usually wound up their description of the model thus:—"Beautifully enamelled and lined in correct colours; all fittings nickel plated." This plating was well carried out, even down to the treads of the wheels!

Yours faithfully,

Devizes. H. GALE.

Factors Influencing the Design of Model Racing Cars

DEAR SIR,—With regard to the difficulty that Mr. Price is having in visualising the reaction effects of the driving wheel torque, a consideration of a basic principle of couples would probably give the required enlightening.

By definition, a couple produces the same moment about any point in its own plane, and therefore, if moments are taken about a point on the ground distant x in front of the leading wheels, with l as wheelbase, and assuming the reactions produced by the driving wheel torque T to be P downwards on the leading wheels and F downwards on the trailing wheels, we have:—

$$F(x + l) + Px = T$$
$$Fx + Fl + Px = T$$
$$\text{but } Fl = T$$
$$\therefore Fx + Px = 0$$
$$\text{or } F = -P$$

(*i.e.*) The pressure P on the leading wheels must be equal, and opposite, to that produced on the trailing wheels, or, in this case, down on trailing and up on leading wheels.

Regarding the "setting" of the wheels, we agree that this is best left to experiment, as skidding tendencies are somewhat unpredictable; but we think that it will be found that the true and experimental "settings" will not be far removed from each other.

It was taken for granted in our article that the tethering pole would be as near as possible (within practicability) to the height of the c.g.; further adjustment can best be made in respect to this problem by experiment, our own ideas being that the best tethering point will be slightly in front of the c.g. and also slightly below it.

We are pleased to see that Mr. Price supports the plea for classification, and consider that the large amount of correspondence which has been handled in connection with our article proves that there is a great deal of interest in the model racing car, which is surely worthy of organisation.

Yours faithfully,

New Seaham. K. PROCTER and CHAS. SNOWDON.